Even as a youth I had a passion for solving problems, challenging myself to overcome obstacles, and exceeding expectations through hard work and determination. In 6th grade I tried to join the Math Club to learn more advanced topics, unfortunately my efforts were thwarted when I discovered the club was reserved for students who needed extra tutoring. I loved competition and enjoyed physical activity, so I threw myself into sports and even though I was undersized, I was always the most determined. Through hard work I scraped my way from the bottom to the top of every team I played for. I would spend whole afternoons trying to “be the ball” as an aspiring soccer player in Spain, run down outfield fly balls and field grounders with my dad in middle school, and dedicate a whole year to train with the track and cross-country team as a chubby high school freshman to earn my spot on the varsity soccer team the following season. Pursuing a PhD in engineering is the ideal fusion of the passions I have had since childhood.

I first knew that I would devote my career towards distributed renewable energy (DER) during a three-day backpacking trip I took with my father in the Rocky Mountains. Nearing the completion of the hike, I climbed up to a vantage point and was completely isolated. I could not believe the beauty and grace of my surroundings but could not shake the dreadful thought that climate change and pollution would destroy this breathtaking landscape in only 20 years. In that moment I decided to devote my career to Power and Energy engineering. This decision would maximize my skills in the global quest to preserve our planet and improve human life.

Prior to this self-discovering moment, I was planning on a career in embedded software and hardware development because it seemed to be the perfect mix of physical constraints and unlimited possibilities of programming. Pursuing this interest, I worked for the Cooperative Engineering Program at Bridge Fusion Systems LLC (BFS), a tiny electrical engineering consulting company that specialized in custom hardware projects. As only the third employee at the company I was assigned my first project: design code and calibrate a test fixture to load and initialize ARM microcontrollers for installation in wi-fi compatible Smart Plugs. At the beginning of my first rotation I had no experience coding with C and Python, and at the end I installed the test fixture and software I designed at the manufacturing company. I recently learned these smart plugs are being installed in two Pittsburgh buildings potentially saving the city $6.3 million in energy costs over the next 10 years[1]. Learning new programming languages, initializing engineering software packages, and completing professional projects were invaluable skills that I was able to take with me back to school and research projects.

Interested in applying what I learned at BFS towards sustainability, I volunteered at a Sustainable Design lab at the University of Pittsburgh. I was the expert in circuitry and embedded programming on the small team of undergraduates building low-cost air quality sensors. The circuits being built for the sensors were difficult to debug and tedious to build, so the project was at a standstill. I was able to quickly identify problems with the circuits but ultimately recommended changing the implementation because of the rigidity of the software being used. Another team in this lab was testing the effectiveness of ultraviolet LEDs to decontaminate water. Unfortunately, their circuit design prevented the LEDs from being operable, but I was able to simplify the project by redesigning their code and adjusting the circuitry. This experience opened my eyes to the interdisciplinary engineering skills required for sustainable projects.

To widen my breadth of understanding, take advantage of opportunities available at a research driven university, and use my skills to benefit the environment I contacted Dr. Thomas McDermott to pursue working on one of his projects focused on sustainability. The project I began with Dr. McDermott would last over three summers and was my introduction to the field of Electric Power. The goal was to develop a process to quickly convert Duquesne Light Company’s (DLC), the local electric utility in Pittsburgh, distribution circuit maps into OpenDSS (an open source distribution system simulator) models. The need for circuit models arose because traditional techniques were not sophisticated enough to analyze the impacts of distributed photovoltaics (PV). To guarantee safe operation of their system, DLC was forced to limit the PV penetration to a measly 15% threshold per circuit. After two summers of designing the process to build circuit models major strides had been made but the project was still incomplete. Determined to apply my models to increase the PV safety threshold, I joined DLC as an intern to enhance the model building process and design PV studies. I initially studied DLC’s two highest PV penetrated circuits and was able to conclude that neither circuit had safety concerns, ensuring DLC was in the clear. Since this was the first study of its kind at DLC and my method of building circuit models uniquely did not require any Geographic Information System data, I published a conference paper for the 2018 IEEE Power and Energy Society general meeting [2].

My experience with DLC was the primary motivating factor to continue learning about the power industry. The systems and data DLC use to manage their distribution circuits were outdated compared to other industries, but standard for utilities. The models I designed were only band-aids; what DLC really needed was and overhaul to the approach of how problems were solved and a willingness to integrate modern technologies into their system. To get a more general philosophy behind the power industry, a universal methodology for understanding the tradeoff among different approaches in practice, and pioneering a research angle for innovating the game, it was necessary to go to graduate school.

Arizona State University was the obvious choice. The university has 12 faculty members researching power and energy, the largest group in the country, and is the lead university in the Power Systems Engineering Research Center (PSERC), a research collaboration between universities and industry devoted to modernizing the electric grid. Here, I will leverage the faculty, resources, and strong industry ties to learn and collaborate with the best. More importantly, ASU made sense because my grandmother lives in Phoenix. In 2014 she had been diagnosed with Alzheimer’s and I could tell she was starting to age quickly. So, to give my grandmother something to look forward to and add stability where my family needed it the most, I promised I would move to Phoenix after my graduation. I have been living with my grandmother for the past 10 months assisting my aunt, a single mother and small business owner, with my grandmother’s care.

My successful implementation of the project at DLC led to a job offer based out of Phoenix as the first and only remote employee at the company. The nature of my position gave me the freedom to pursue research opportunities at ASU and take classes part-time. When I discovered the interdisciplinary research between Machine Learning and Power Systems that Dr. Yang Weng was conducting, I was utterly blown away. Dr. Weng has leveraged the data analytic techniques of machine learning to revolutionize utility capabilities with minimal cost, leading to five best paper awards in the past six years. Working with Dr. Weng the last six months I have begun to understand the initial philosophy of using data to represent physical systems and how instrumental machine learning is going to be for the future of the power industry. My continued work with Dr. Weng will provide me the opportunity to master the fundamentals of machine learning to motivate control actions necessary to operate DER, connect the universal methodology among different learning methods, and leverage the unlimited potential of artificial intelligence (AI) to link heterogenous data from diversified domains to revolutionize the power industry and human life. Therefore, I am ecstatic to begin my PhD studies this Spring focusing on the fundamental relationships between machine learning, statistics, and the electric grid.

Outside of my studies I have continued to improve as an athlete; I transformed myself from the worst player on the Ultimate Frisbee team at Pitt to Captain and team MVP as a senior and am currently considered world-class in the sport. Aside from relieving stress and giving me goals to work towards, ultimate frisbee has taught me the importance of highlighting individuality in a team setting, provided invaluable leadership opportunities, and given me a different space to creatively problem solve. This unique sport awarded me opportunities I never could have imagined, including catching a world championship winning goal for the Under-24 Men’s National team and using my platform to publicly advocate for gender equity [3]. I owe it to the community that gave me so many opportunities to succeed to give back, so I have volunteered to assistant coach the ASU Men’s Ultimate Frisbee team this upcoming season. I plan on continuing as a coach during my stay at ASU and am looking forward to teaching, developing, and being inspired by the upcoming generation of players.

To broaden my volunteering efforts and benefit my family I have begun tutoring my younger cousin with his high school math homework. I am using this opportunity to build our relationship and eventually inspire him to care about more than video games and shoes. This has given me the opportunity to work on a person and being a positive influence on my cousin has been incredibly rewarding. Not only has this ignited my eagerness to help my future students as a teaching assistant, but it has inspired me to pursue STEM outreach opportunities through ASU to mentor the upcoming generation of engineers.

The NSF graduate research fellowship program will give me the resources to continue my mission to modernize the power industry. Reflecting my history as a co-op, undergraduate researcher, intern, and ultimate frisbee player I will maximize the resources and opportunities at ASU. By combining the spirit of the NSF and my passions, I will be able to achieve my long-term career goal of helping people not only in my family, school, or city, but worldwide. Whether I knew it or not, I have been preparing my whole life to pursue a PhD and am equipped to wholeheartedly commit to becoming an expert in AI applied to DER generation and control.

# **References:**

|  |  |
| --- | --- |
| [1] | B. Bauder, "Bloomfield tech company could save Pittsburgh $6.3M in energy costs," 28 August 2018. [Online]. Available: https://triblive.com/local/allegheny/14020300-74/city-planning-to-use-smart-plugs-and-magic-boxes-for-high-tech. |
| [2] | C. W. Morgenstern, S. R. Abate, E. Cook and T. E. McDermott, "Distribution Model Creation using Circuit Maps and Applied PV Impact Studies," in *IEEE Power and Energy Society General Meeting*, Portland, Oregon, 2018. |
| [3] | C. Morgenstern, "Why Pro Ultimate Should be Mixed," 2 October 2017. [Online]. Available: https://skydmagazine.com/2017/10/why-pro-ultimate-should-be-mixed/. |